Submarine Topography and Several Bottom Sediments around Prince Olav and Prince Harald Coasts, Antarctica

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Prince Olav Coast および Prince Harald Coast 付近の海底地形と底質について

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要　旨

南極大陸とアフリカ大陸との間には，中央大西洋海嶺の延長とみられる西南西方向の海嶺があり，大洋底は南北2区に分けられる．北部は水深5,000～5,200mでやや凹凸に富むが，南部は5,200～5,300mで平坦である．南極周縁の大陸棚は，300～400mの外縁深度を有し，幅は60～70km以上に達する．陸棚斜面は4,000m以深で緩傾斜になる．

第5次航海で得られた11地点の資料についてみると，大陸棚上の底質はかなり砂質で礫も伴うが，Prince Olav Coast や Amundsen Bay 付近沖の陸棚斜面上部の底質は泥質である．しかし，これらの泥質堆積物は半遠洋性粘土の特徴を呈し，SiO_2 に富み，$CaCO_3$・Fe_2O_3・Al_2O_3・P_2O_5 などに乏しい．このことは，陸源性砕屑物の供給がかなり多いことを示すものであろう．

Abstract: The deep sea floor between Africa and Antarctica is divided into two provinces by the continuation of Mid-Atlantic Ridge. The bottom sediments on the continental slope around Prince Olav Coast and Amundsen Bay are hemipelagic clays which are rich in SiO_2 and poor in $CaCO_3$, Fe_2O_3, Al_2O_3 and P_2O_5.

1. Introduction

Numerous soundings had been carried out during five expeditions from 1956 to 1961. The data taken by the UMITAKA-MARU and SOYA's first expedition have been reported by KUMAGORI et al. (1958) and SHOJI and SATO (1959), respectively. Concerning the bottom sediments, NIINO (1958) reported on the samples dredged by the UMITAKA-MARU and SHOJI and SATO (1959) on those by SOYA's 2nd expedition. In the present paper, the author will describe about the soundings of the 2nd to the 5th SOYA's expedition and the bottom sediments taken by the 5th SOYA's expedition.

Sounding data treated in this report were arranged by the members of Japanese Hydrographic Office. The bottom samples were obtained by Mr. S. HORI, member of the JARE-V. The author expresses hearty thanks to these gentlemen.

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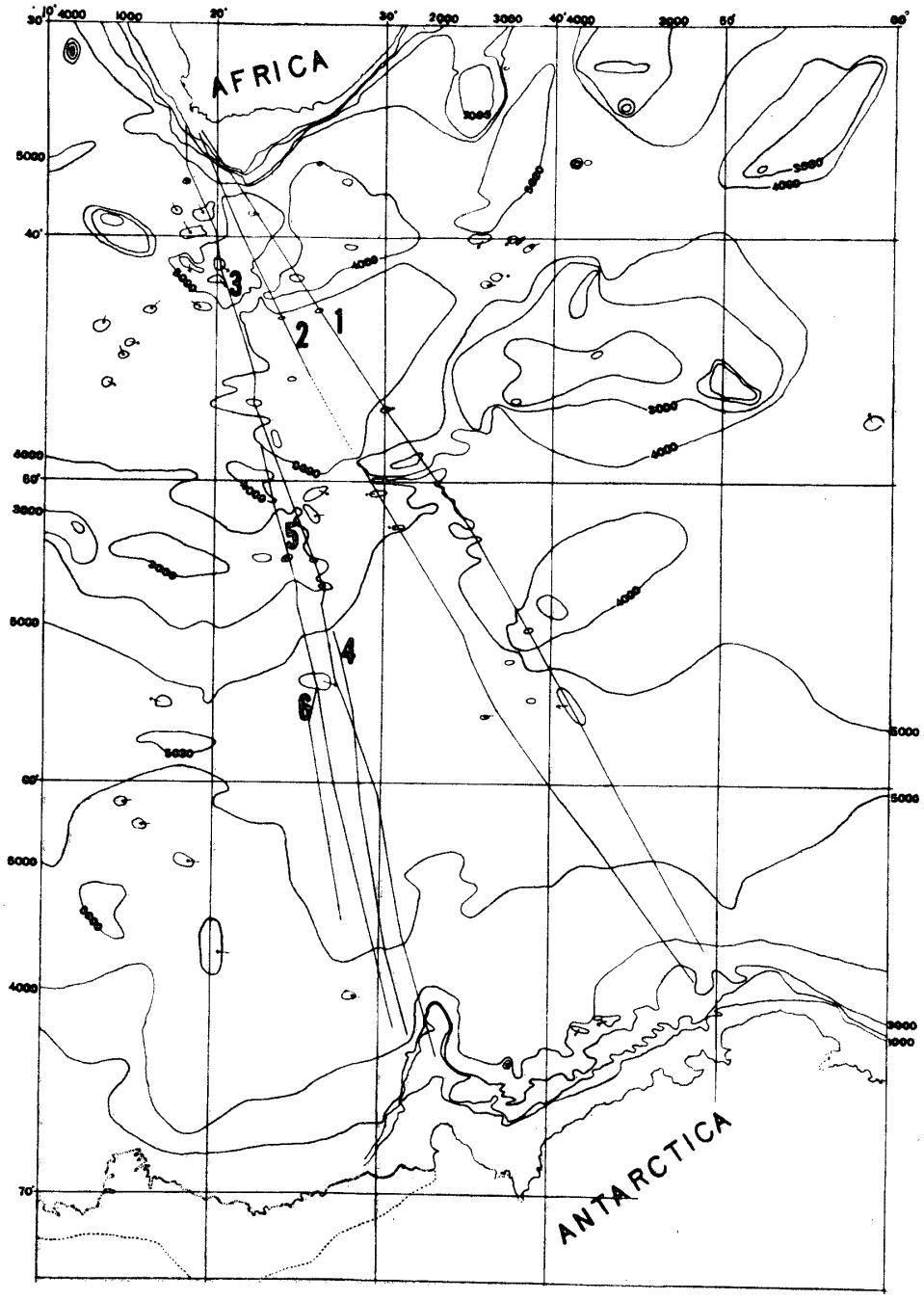

Fig. 1–1. Sounding tracks between Africa and Antarctica.

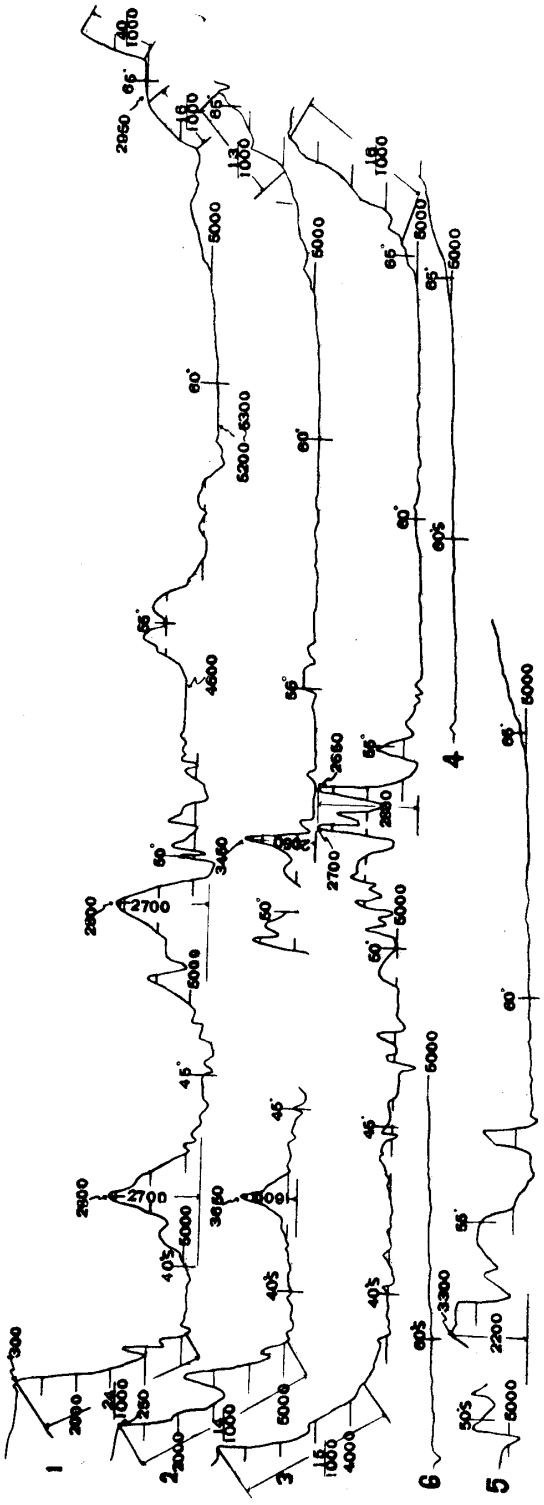

Fig. 1–2. Topographic profiles.

2. Submarine topography

A. Africa to Antarctica

Soundings were shown in the figures of tracks and topographic profiles. Original sounding data are preserved in the Japanese Maritime Safety Board.

Continental shelf off Cape Town southern end of Africa ranges from 80–240 km of width and 250–300 m of edge depth. The foot of the continental slope is about 5100–5200 m deep. The apparent gradient of the slope is about (14–24)/1000 on the topographic profiles, so the true gradient of slope is probably about 80/1000 (less than about 2°). A height of 600 to 1000 m is seen at 3000 m deep on the slope.

The ocean floor between Africa and Antarctica is divided into two provinces by a large range of WSW direction, which is seen at a south mountain on profiles 1 and 2, and at that on profiles 3 and 5. These mountains are 2000–2800 m high and the shallowest peak about 2700 m deep. EWING and HEEZEN (1956) suggested that Mid-Atlantic Ridge elongated to Pacific and Indian Oceans via southward of Africa. The mountains above mentioned are the continuation of Mid-Atlantic Ridge.

The ridge divides the ocean floor into northern and southern provinces. The southern province is a very flat floor 5200–5300 m deep which is seen on the profiles 1,2,3,4,5 and 6. The northern province has also a flat part of 500–5200 m deep and besides shows fairly rugged relief; profiles 1 and 2 show mountains of 1600–2700 m high.

The continental slope of Antarctica side also seen to have similar gradient to the African side.

B. Submarine topography in Antarctica side

Sounding results are shown in the figures of tracks and profiles.

a: Off Enderby Land

The continental slope decreases its gradient in deeper than 3000 m deep as seen on profiles III-1 and 2 and V-1, and becomes gentle slope as seen on IV-1. The slopes shallower than 3000 m have relieves as seen on III-3, IV-8 and 9 and V-2 which may suggest the existence of submarine canyons.

b: Off Prince Olav Coast

Longitudinal profiles of continental slope show the slope with moderate relieves and extend to deeper than 4000 m deep as seen on IV-13–16. Transverse profiles show smooth slope probably without submarine canyon, as seen on III-4, IV-7–10, V-3 and 4 and 6–8.

c: Lützow-Holm Bay

The continental slope extends to deeper than 4000 m deep as seen on V-10 and IV-13. Transverse profiles such as II-5–8, IV-2–4, 6 and 11, V-5 and 9–11, show that the base of the slope is a flat floor of 4500 m deep and the slope has moderate relieves.

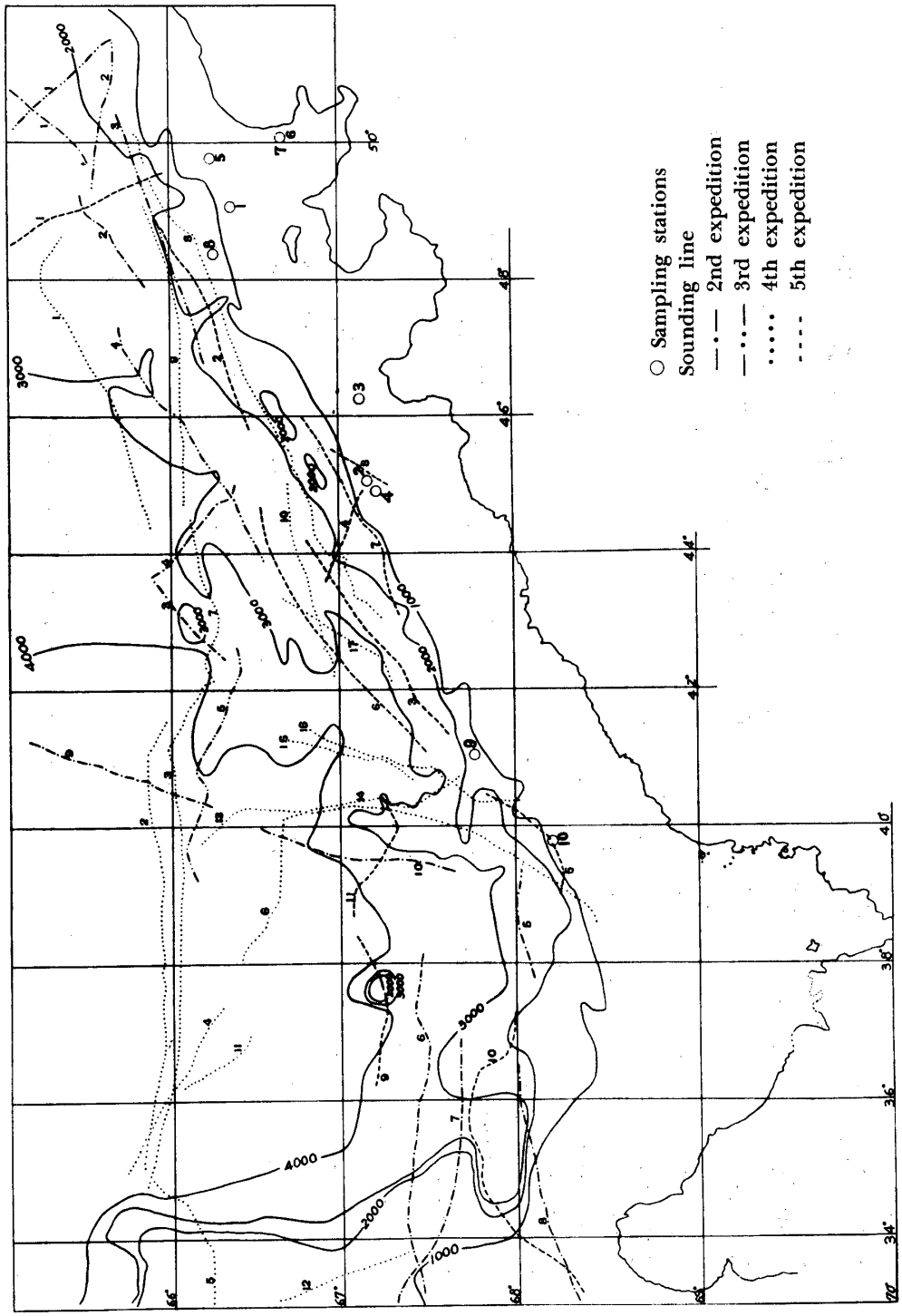

Fig. 2–1. Sounding tracks and sampling stations.

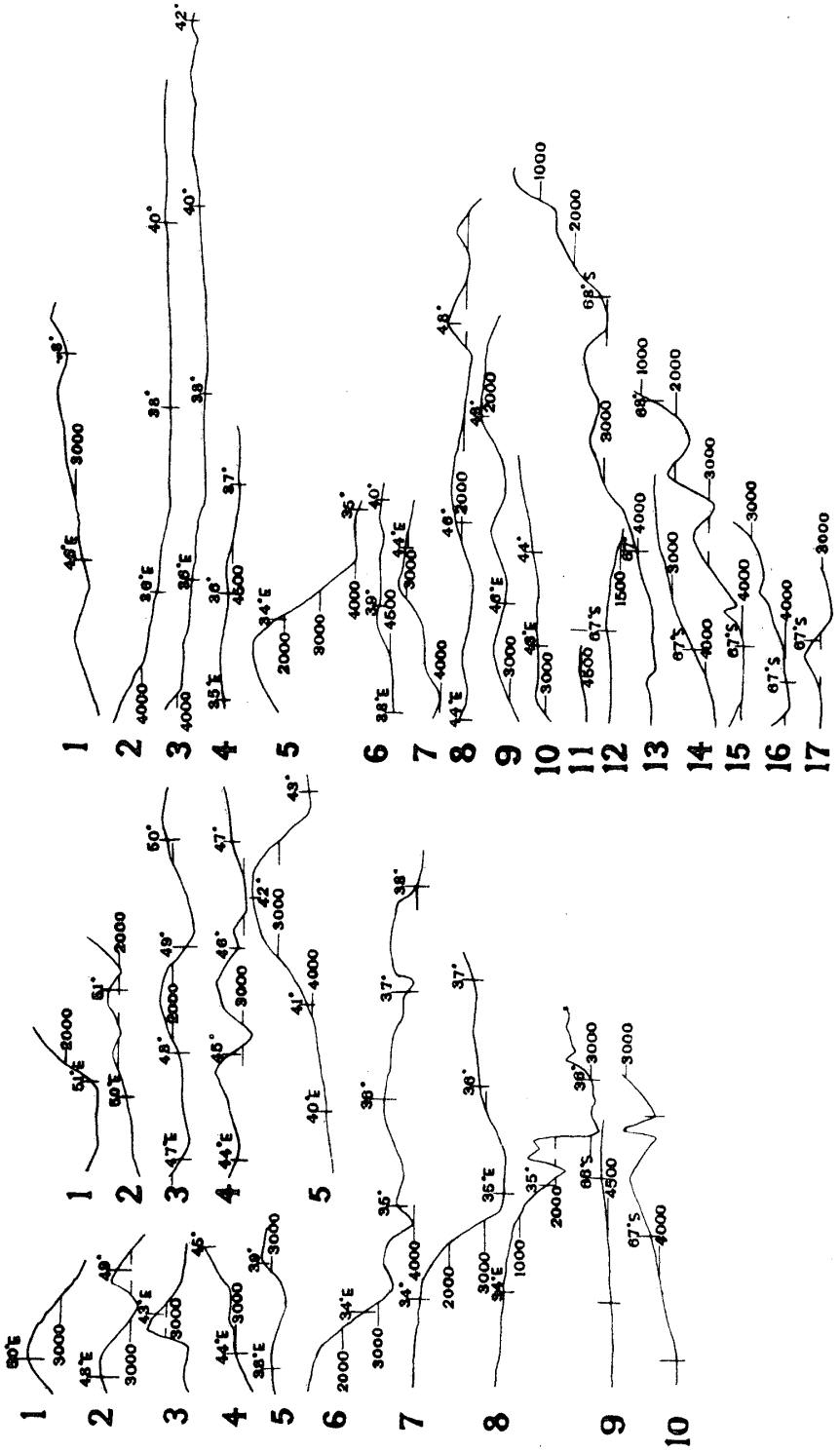

Fig. 2–2. Topographic profiles.

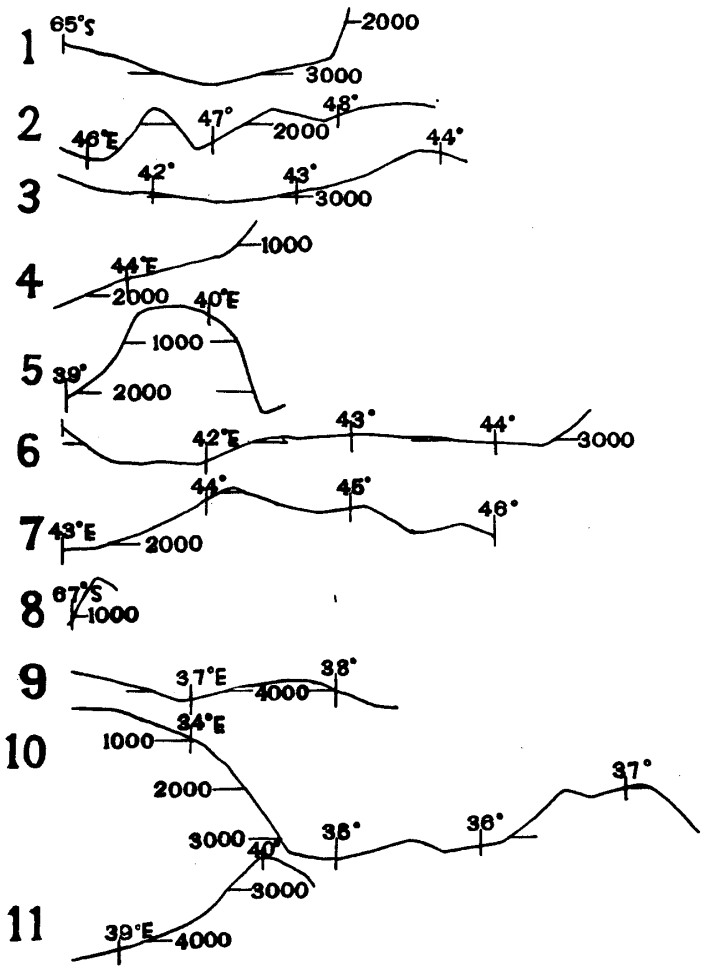

Fig. 2–3. Topographic profiles of 5th cruise.

d: Continental shelf

The depth of shelf edge is 300–400 m deep off the eastern part of Lützow-Holm Bay and 500–600 m deep on Gunnerus Bank, northward of Cape Cook. The width of the shelf is 60 km off Prince Olav Coast and more than 70 km off Lützow-Holm Bay.

3. Bottom sediments

By the 5th cruise of the SOYA, 18 samples have been taken at 11 stations. The author will report the results of grain-size analysis and chemical analysis. But such researches are going to be done by other researchers as mineral component analysis, clay mineral analysis and organic matter analysis.

St. 1 is situated at the upper part of continental slope northward of Amundsen Bay and Enderby Land. It is composed of coarse materials and much gravel. Sts. 2 and 3 are situated at shelf edge off the eastern part of Prince Olav Coast. It contains also angular gravels. St. 4 is situated at a slightly deeper part than the shelf edge in the same area. It is muddy without coarse material. St. 5 is situated on continental shelf off Amundsen Bay. Sts. 6 and 7 are situated off Mt. Larsen in Amundsen Bay. Here it is about 400 m deep in average, but the Sts. 6 and 7 show about 1000 m depth which may suggest the presence of submarine canyon. They don't contain gravels. St. 8 is on the continental shelf off White Island and Amundsen Bay. It contains angular gravels. St. 9 is the deepest station in this cruise, and situated on continental slope off Prince Olav Coast. St. 10 is on the continental shelf off Prince Olav Coast and is sand and angular gravels. St. 11 is situated at the southwestern shallow on

Table 1. Records of bottom sediments.

Station	Date	Lat. S	Long. E	Depth	Sampler	Notation
1	Jan. 7	66-22.0	49-09.5	945 m	dredge	G•fS
2	Feb. 9	67-10.5	45-01.5	385	〃	G•SM
3	9	67-07.0	46-15.0	280	〃	G•SM
4	11	67-13.0	44-50.5	560	〃	M
5	15	66-33.5	49-38.5	330	〃	G•MS
6	16	66-41.0	50-02.0	980	〃	MS
7	16	66-41.0	50-03.0	1020	corer	M
8	17	66-33.5	48-21.0	275	dredge	G•SM
9	21	67-47.0	41-01.0	1750	corer	M
10	22	68-12.0	39-43.5	380	dredge	G•fS
11	Mar. 1	68-53.0	30-56.0	190	〃	G•fS

Table 2. Results of grain-size analysis.

Station	ϕ16	ϕ25	ϕ50	ϕ75	ϕ84	Gravel	
						Maximum diameter	Mean diameter
1	1.8	2.1	2.7	3.6	4.1	4 cm	2-3 cm
2	1.6	2.2	3.5	6.2	7.5	4.5	1-2
3	1.4	2.4	3.9	5.6	6.9	3	1-2
4	3.9	4.7	6.1	8.1	—	—	—
5	2.4	3.1	4.5	6.8	7.7	2	1
6	3.3	3.5	4.6	7.2	8.2	—	—
8	2.6	3.0	3.6	4.9	6.0	4	2-3
10	1.2	1.9	2.7	3.6	4.2	4	1-2
11	—	0.7	2.2	3.6	4.3	3.5	1-2

Gunnerus Bank. It contains coarse materials and many fragments of organic remains.

The samples on continental shelf such as Sts. 2, 3, 5, 8, 10 and 11 are fairly sandy and contain gravels. The organic materials on Gunnerus Bank have been ascertained by the 2nd expedition. The samples on continental slope such as Sts. 1, 4, 6, 7 and 9 are muddy except in the case of St. 1 which is abnormal sediments containing sand and gravels, and seems to be the results of iceberg transportation.

Gravels range 4 to 4.5 cm of maximum diameter and 1–2 cm of average diameter. All are very angular. They are chiefly composed of granite or gneiss.

Chemical analysis

Sts. 4, 7 and 9 are sampled by small gravity corer. Chemical analyses are done about them, the position of samples below bottom ground being shown in Table 3. These three samples are the muds on the continental slope of which Sts. 4 and 7 represent the bottom near to continental shelf or in the environs of submarine canyon and St. 9 is hemipelagic sediment.

Table 3. Samples used for chemical analysis.

Station	Depth below bottom
4	− 7 to 16 cm
7	−15 to 21
9	−24 to 31

Table 4-1. Chemical composition.

	St. 4	St. 7	St. 9
SiO_2	65.51	69.18	63.37
Al_2O_3	12.13	11.17	16.08
Fe_2O_3	4.80	4.62	5.18
CaO	3.53	3.10	4.97
MgO	2.62	2.34	2.31
Na_2O	3.77	2.87	4.49
K_2O	1.96	1.81	1.70
H_2O^+	0.87	0.55	0.32
H_2O^-	2.88	2.03	0.81
TiO_2	0.57	0.54	0.75
P_2O_5	0.18	0.08	0.29
MnO	0.13	0.06	0.11
CO_2	0.00	0.05	0.02
Cl_2	1.55	1.21	0.38
SO_3	0.15	0.30	0.37
Org. C.	0.53	0.88	0.23
$CaCO_3$	—	0.11	0.05

Table 4-2. Chemical compositions excluded $CaCO_3$, water and residual salts.

	St. 4	St. 7	St. 9
SiO_2	69.85	73.01	63.89
Al_2O_3	12.93	11.80	16.22
Fe_2O_3	5.12	4.88	5.22
TiO_2	0.61	0.57	0.76
P_2O_5	0.19	0.08	0.29
MnO	0.14	0.06	0.11
CaO	3.71	3.22	4.98
MgO	2.61	2.40	2.33
Na_2O	2.78	2.11	4.50
K_2O	2.05	1.88	1.72
Total	100.00	100.00	100.00

$CaCO_3$: The samples show small quantities but St. 9 has relatively high value. The calium carbonate content is concerned to the dilution of carbonaceous organic remains by detritus sediments. The values of Sts. 4 and 7 show the plenty of detritus.

Fe_2O_3: Total iron are presented in the form of ferric oxide. In general, the content of iron and manganese is higher in pelagic deposits than in the terrigenous ones. The three are poor in iron and manganese, because of the dilution by detritus.

SiO_2: The three show high content of silica, but St. 9 which is the deepest sample, has relatively low content.

Al_2O_3: Generally, alumina content is rich in clayey sediments. The three have low value of Al_2O_3 which means the plenty of detritus. But St. 9 presents relatively high content.

P_2O_5: Fairly poor in the three.

The results of chemical analysis indicates that these three samples are terrigenous sediments rich in detritus from land. But St. 9 the deepest sample, has somewhat hemipelagic character.

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